

U.S. Patent Application of BEASE et al., Appln. No. 10/644,957

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REMARKS

No claims are amended hereby. Accordingly, claims 1-36 remain pending. Claims 17-36 are withdrawn from consideration.

In the Office Action dated March 17, 2006, the Examiner rejected claims 1-16 under 35 U.S.C. § 112, first paragraph, for failing to comply with the written description requirement. In particular, the Examiner stated that the amendment to the claims to recite that the high-permittivity material is substantially free of silicon added new matter to the claims. The Applicant respectfully disagrees with the Examiner's position and, therefore, respectfully traverses the same.

It is clear from the specification and the claims that the high-k materials listed, among them Ta₂O₅, TiO₂, ZrO₂, Al₂O₃, and HfO₂, do not contain silicon. Therefore, the limitation that the Applicant has added, that the high-permittivity material be substantially free of silicon, is supported by the various species of high permittivity materials discussed in the specification. The addition of this limitation focuses the claims only on those materials that the Applicant chooses to protect by the claims presented in this application. The fact that the specification contains HfSiO has little bearing on the amendment since the Applicant is free to select from the specification those aspects for which the Applicant seeks patent protection. Clearly, the specification describes both high permittivity materials that include silicon and those that are substantially free of silicon. As a result, the specification fully supports the Applicant's amendment. Accordingly, the Applicant respectfully requests that the Examiner reconsider and withdraw the rejection.

In the Office Action, the Examiner also rejected claims 1-10, 15, and 16 under 35 U.S.C. § 103(a) as unpatentable over Yu et al. (U.S. Patent No. 6,818,553) in view of Yang et al. (U.S. Patent No. 6,579,809). In addition, claims 11, 12, and 14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yu et al. and Yang et al. and further in view of Ranft et al. (U.S. Patent No. 6,536,449). Next, the Examiner rejected claim 13 under 35 U.S.C. § 103(a) as being unpatentable over Yu et al. and Yang et al. and further in view of Otsuki (U.S. Patent Application Publication No. 2001/0003271). The Applicant respectfully disagrees with each of these rejections and, therefore, respectfully traverses the same.

In the Office Action, the Examiner also rejected claims 1-16 under the judicially-created doctrine of obviousness-type double patenting as being

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unpatentable over claims 93 and 95-104 of co-pending application No. 10/670,795) in view of Yu et al., Ranft et al., and Otsuki. The Applicant respectfully disagrees with this rejection and, therefore, respectfully traverses the same.

Turning first to the Examiner's assertion of an obviousness-type double patenting rejection, the Applicant respectfully resubmits its request that the rejection be withdrawn. Claims 93-104 from the co-pending application are reproduced below:

93. A method of processing a layer containing a high-permittivity material, the method comprising:
modifying a layer containing a high-permittivity material by exposing the layer to a first process gas in a plasma; and

etching the modified high-permittivity layer in the absence of a plasma by exposing the layer to a second process gas comprising an etch reactant.

94. The method according to claim 93, wherein the layer containing a high-permittivity material overlies another layer in a substrate.

95. The method according to claim 94, further comprising providing the substrate in a process chamber.

96. The method as claimed in claim 93, wherein the modifying step partially removes the layer containing the high-permittivity material.

97. The method as claimed in claim 93, wherein the modifying step partially disassociates the layer containing the high-permittivity material.

98. The method according to claim 93, wherein the first process gas comprises a reactive gas.

99. The method according to claim 96, wherein the reactive gas comprises at least one of HBr and HCl.

100. The method according to claim 98, wherein the first process gas further comprises an inert gas.

101. The method according to claim 100, wherein the inert gas is selected from He, Ne, Ar, Kr, Xe, and N₂, or mixtures thereof.

102. The method according to claim 93, wherein the first process gas comprises an inert gas.

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103. The method according to claim 102, wherein the inert gas comprises at least one of He, Ne, Ar, Kr, Xe, and N₂.

104. The method according to claim 93, wherein the high-permittivity material comprises at least one of Ta₂O₅, TiO₂, ZrO₂, Al₂O₃, HfSiO, and HfO₂.

As pointed out previously, claims 94-104 depend from claim 93. As claim 93 makes apparent, the claims require etching the modified high-permittivity layer in the absence of a plasma by exposing the layer to a second process gas comprising an etch reactant. Use of a second process gas for etching is quite different from wet etching, which is required by claims 1-16 in the present application. As a result, the Applicant respectfully submits that claims 1-16 are not obvious in view of claims 93 and 95-104 in the co-pending application. Accordingly, the Applicant respectfully requests that the Examiner withdraw the provisional obviousness-type double-patenting rejection.

The Applicant acknowledges the Examiner's position in response to the Applicant's prior response. The Applicant, however, respectfully disagrees. If the Examiner chooses not to withdraw the obviousness-type double patenting rejection, the Applicant respectfully requests, in the alternative, that the Examiner hold the obviousness-type double-patenting rejection in abeyance. While the Applicant chooses not to amend the claims further at this juncture, the Applicant is sensitive that other changes may be proposed in the future. Those changes may moot the Examiner's rejection. Accordingly, the Applicant respectfully requests that the Examiner hold the obviousness-type double patenting rejection in abeyance until all of the rejections in view of the prior art are resolved.

Turning now to the rejections in view of the prior art, the Applicant respectfully submits that claims 1-16 are patentably distinguishable over the references cited by the Examiner because each of the claims now recite that the high-permittivity material is substantially free of Si. None of the references describe or suggest an apparatus or a method that combines features with at least this feature. Accordingly, the Applicant respectfully submits that the references relied upon by the Examiner may not be combined in the manner suggested. As a result, the Applicant respectfully submits that claims 1-16 are patentable and should be passed quickly to issue.

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Yu et al. fails to assist in rendering obvious claims 1-16 for at least two reasons. First, Yu et al. does not describe etching of any high-k materials that are substantially free of Si. Second, since all of the high-k materials discussed by Yu et al. include Si, it may be said that the reference teaches away from claims 1-16.

Yu et al. describes an etching process to be performed on a high-k gate dielectric layer 14, which is preferably comprised of $ZrSiO_4$, $HfSiO_4$, $LaSiO_4$, $YSiO_4$, $ZrSi_xO_y$, or $HfSi_xO_y$. (Yu et al. at col. 2, lines 24-29.) As is immediately apparent, each of the high-k materials listed include Si. Since Yu et al. is directed to etching of high-k materials that include Si, the Applicant respectfully submits that Yu et al. may not be relied upon in combination with the remaining references to render obvious any of claims 1-16. Those of ordinary skill in the art simply would not think to look to a reference concerning Si-containing materials for any teaching that may be applied to materials substantially free of Si.

Yu et al. describes a process where, after formation of the poly-silicon layer, the structure is subjected to argon sputter or fluorine-based-chemistry plasma etch 24. (Yu et al. at col. 2, lines 58-67.) A wet etch 26 is used to remove remaining portions of the high-k dielectric material. (Yu et al. at col. 3, lines 46-54, for example.) Nowhere does Yu et al. describe the use of a plasma etch followed by a wet etch for high-k materials that are substantially free of silicon. Accordingly, Yu et al. does not provide a proper basis upon which to formulate a rejection of the claims.

Yang et al. describes an in-situ gate etch process for fabrication of a narrow gate transistor structure with a high-k dielectric. In the exemplary embodiment, the high-k dielectric material forms the etch stop layer 62. (Yang et al. at col. 5, lines 5-9.) The high-k dielectric material 62 is removed using an etch chemistry of HBr, He, or CF_4 . (Yang et al. at col. 7, lines 20-27.) While Yang et al. does list high-k materials such as HfO_2 , ZrO_2 , CeO_2 , Al_2O_3 , TiO_2 , and Y_2O_3 , Yang et al. does not describe or suggest modifying the layer containing the high-permittivity material by exposing the layer to a plasma nor does it describe removing the modified layer. (See, e.g., Yang et al. at col. 4, lines 39-43.) Accordingly, the Applicant respectfully submits that Yang et al. cannot be combined properly with Yu et al. to render any of the claims obvious. As a result, the Applicant respectfully requests that the Examiner withdraw the rejection.

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In Yang et al., the removal of the high-k dielectric 62 is accomplished with an etch chemistry of HBr, He, or CF₄. (Yang et al. at col. 7, lines 20-23.) There is no discussion of the removal occurring via a plasma process. Following removal of the high-k material, there is a step where the wafer and the hard mask are wet cleaned using hot phosphoric acid. (Yang et al. at col. 7, lines 28-33.) As would be appreciated by those skilled in the art, application of a "wet clean" step indicates that all of the material has been etched and that further etching is not required. In addition, as also would be appreciated by those skilled in the art, a "wet clean" step differs from a wet etch step in that a "wet clean" is designed to remove residual materials remaining in spots on the wafer, not to further etch materials already removed. As a result, those skilled in the art would not think to combine Yang et al. with Yu et al. for the simple reason that the two processes are non-analogous.

The Applicant further respectfully submits that the combination of Yang et al. with Yu et al. appears to be merely a hindsight reconstruction by the Examiner. Since Yu et al. fails to describe high-k materials that are substantially free of silicon, it appears that the Examiner is relying on Yang et al. for etching of high-k materials that are substantially silicon free. However, in so doing, the Examiner appears to have overlooked that the process in Yang et al. is quite different from Yu et al. in that the etch step in Yang et al. completely etches the high-k dielectric layer and, therefore, does not "modify" the layer. Moreover, the Examiner appears to have overlooked that the "wet clean" step is not a wet etch, but is merely a step to remove residual materials left on the wafer surface, among others. As a result, the Applicant respectfully submits that Yang et al. cannot be properly combined with Yu et al. to arrive at the present invention, as now recited by claims 1-16.

Ranft et al. also does not assist the Examiner in fashioning a rejection of the claims. Ranft et al. describes a downstream surface cleaning process. Ranft et al. does not describe or suggest modifying the layer containing the high-permittivity material by exposing the layer to a plasma nor does it describe removing the modified layer. Accordingly, the Applicant respectfully submits that Ranft et al. cannot be combined properly with any of the remaining references to render any of the claims obvious. As a result, the Applicant respectfully requests that the Examiner withdraw the rejection.

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Otsuki also does not assist the Examiner in fashioning a rejection of the claims. Otsuki describes a processing apparatus with a chamber having therein a high-corrosion-resistant sprayed film. Otsuki does not describe or suggest modifying the layer containing the high-permittivity material by exposing the layer to a plasma nor does it describe removing the modified layer. Accordingly, the Applicant respectfully submits that Otsuki cannot be combined properly with any of the remaining references to render any of the claims obvious. As a result, the Applicant respectfully requests that the Examiner withdraw the rejection.

Each of the rejections asserted by the Examiner having been addressed, the Applicant respectfully submits that claims 1-16 are patentable over the references cited by the Examiner. Accordingly, the Applicant respectfully requests that the Examiner withdraw the rejections asserted against claims 1-16 and pass this application quickly to issue.

If the Examiner believes a telephone conference would be helpful, she is invited to contact the undersigned at the telephone number given below.

Respectfully submitted,

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